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MICOM ltr, 27 Sep 1976

TECHNICAL REPORT RG-75-28

NORTH SEEKING GYRO LATITUDE SENSITIVITY

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December 1974

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1. REPORT NUMBER: RG-75-28	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE *(and Subtitle)*: NORTH SEEKING GYRO LATITUDE SENSITIVITY	5. TYPE OF REPORT & PERIOD COVERED: Final 30 Aug 74 - 25 Sep 74
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): William W. Stripling	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: US Army Missile Command, AMSMI-RG, Redstone Arsenal, Alabama 35809	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: PBC No. 33P601-BN-00-7300, AMCMS Code No. 2200.23.5412.1.31
11. CONTROLLING OFFICE NAME AND ADDRESS: US Army Missile Command, AMSMI-RPR, Redstone Arsenal, Alabama 35809	12. REPORT DATE: 30 December 1974
	13. NUMBER OF PAGES: 6
14. MONITORING AGENCY NAME & ADDRESS *(if different from Controlling Office)*	15. SECURITY CLASS. *(of this report)*: Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT *(of this Report)*

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17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

18. SUPPLEMENTARY NOTES

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Standard deviation
PERSHING Azimuth Reference Unit Gyro Assembly
North Seeking Gyros

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

Tests to evaluate latitude dependent performance variations of North Seeking Gyros were conducted using a PERSHING Azimuth Reference Unit Gyro Assembly. The instrument was calibrated at Santa Monica, California, operated at three latitudes in Germany, then rerun at Santa Monica to verify the calibration.

Results of tests performed demonstrated gyro performance within accuracy analysis and projected response times. Increasing variation of the mean with latitude evidenced during the tests requires additional data before explanation.

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A program to evaluate latitude dependent performance variations of North Seeking Gyros was conducted with the PERSHING Azimuth Reference Unit Gyro Assembly (AG-7). The instrument was calibrated at Santa Monica, California (latitude 34°), then operated at three latitudes in Germany, (40°, 51°, and 55°), then subsequently rerun at Santa Monica to verify the calibration. The test was begun on 30 August 1974 and completed 25 September 1974. Of particular concern was reaction time, standard deviation and mean variation. Gyro Assembly Serial No. 4 was selected and demonstrated excellent performance both in repeatability and reliability. After initial calibration no maintenance was required during the program. The procedure was to run a sequence of one course north determination followed by three fine north determinations. After each sequence of fine determinations the gyro was slewed off north 15° clockwise and 15° counterclockwise alternately. At each German site, a minimum of 40 fine determinations was made. Due to the lack of verified surveys, the theodolite azimuth circle was set with best known reference and data corrected on subsequent astronomic surveys. See Table 1.

TABLE 1. TEST RESULTS

Date 1974	Location	Latitude	Standard Deviation (sec lσ)	Variations of Mean From Survey (sec)	Average Coarse Reaction Time (min)	Reaction Time (min)
8/30	Santa Monica, CA	34° 1	4.84	calibration	---	4.67
9/14	Ochenhausen, Germany	48°4'0.9"	7.0	-8.10	3.37	4.91
9/4	Geilenkirchen, Germany	50°57'40"	8.42	-18.15	3.52	4.99
9/9	Wallbull, Germany	54°46'40"	6.3	-27.25	3.39	5.20
9/25	Santa Monica, CA	34°1'	3.87	-9.5	3.20	4.79

The standard deviation was probably more dependent on the soil and weather environment than the latitude. The Santa Monica data was acquired in a laboratory while the Germany data was under field conditions, though protected somewhat by a tent. The Ochenhausen and Wallbull sites were on soft soil, while the Geilenkirchen point was on a macadam airfield runway. The wind was appreciably higher at Geilenkirchen and many visitors were present around the gyro during gyrocompass operation. The vibration through the hard surface to the tripod, and the wind were considered major contributors to the higher one-sigma value. These same comments are true also for reaction times. In computing average reaction times three data points were omitted because of obvious disturbance by visitors during the servo monitor time, which recycles if a predetermined threshold is exceeded at the end of the fine north determination sequence.

The rerun at Santa Monica on 25 September was with the system as received from Europe. It was evident that the levels were out of calibration and the time of shift was unknown. A second run was made with unit releveled. See Table 2.

TABLE 2. SANTA MONICA POST CALIBRATION

Standard Deviation ($\widehat{sec}$)	Variance from Calibration ($\widehat{sec}$)	Remarks
3.87	-9.5	As received
5.2	-8.0	Releveled
8.7	-3.6	Cover removed

The variance from original calibration was 1.5 sec improved which is insignificant. It was noted that the bias was increasing between bias set and read time. This bias drift causes a proportional error and seems to be caused by increased temperature in the electronics assembly. With the cover removed, the variance from the original calibration was 3.6 sec. This could have been a contributor to the pre- and post-calibration difference as it is not known when the bias started drifting. It also appears that a bias stability problem of this magnitude is peculiar only to this one unit.

The variation of "mean from survey" increased with latitude. There is no mechanization of the instrument that is a known contributor of this sensitivity. The standard deviation was expected to expand, but the mean was not expected to deviate beyond the one-sigma deviation. If additional test time had been available, it probably would have given a better understanding of this apparent variation, but no revisits of test sites were allowed within the instrument availability time. The error does not exceed the system requirement even if the error is real.

Studies have predicted that latitude variations from 34° to 55° plus temperature variations from 72°F to -25°F would extend coarse and fine alignment times by approximately one minute. The test demonstrated a maximum coarse delta time of 0.32 minutes and a maximum fine delta time of 0.53 minutes. The temperature was fairly benign during the tests, so this change is attributed to latitude only. The -25°F temperature effect would be a 0.41 minute increase in gyro runup time over ambient conditions. The sum of these two efforts is compatible with the projection.

The program demonstrated north seeking gyro performance within the analytic accuracy analysis and the projected response times. The increasing variation of the mean with latitude requires additional data for a conclusive explanation.

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